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LNBUG #6.0
6500 DEVELOPMENT SYSTEM

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LNBUG 6500 DEVELOPMENT MONITOR

INTRODUCTION: The MCS6500 Development Monitor is a comprehensive debug package including complete list and modify commands, mini-assembler/disassembler, disc and tape communications, stepping, trace, and breakpoint capabilities, and other useful memory manipulation commands. The program is designed to run on an S-100 type computer utilizing an Atari trace memory interface board with a video or hard copy terminal.

To run the monitor, the system must be configured as follows:

- 1 - Atari GVA-2503 CPU card (or Coleen wire wrap CPU)
- 1 - Dynabyte 16K RAM card
- 1 - Cromemco 16K ROM card
- 1 - Atari GVA-2504 Trace Memory Interface Card

Make sure to set switches as specified on sheet labeled "DEVELOPMENT SYSTEM SWITCHES." A copy of this is included at the back of this manual.

With the BOOTSTRAP switch on, the monitor will be entered upon reset, starting at location 6000 (GVA-2503 only).

If reset is desired to clear vectors and reset all monitor cells, a carriage return should be the first character entered. A "Cool" Reset will clear everything except patches and breakpoints. (Type "C".) A "W" causes a warm reset and clears nothing. The monitor will echo

"NOW ENTERING LNBUG #X"

to indicate the entry to the monitor and the version being used.

After a "Cold" reset, the user must select the control set for the terminal being used:

Type "H" <CR> for a hard copy terminal.
For Lear Siegler, type nothing.

The monitor is now ready for operation.

Note: See Appendix on Interrupt Handling for Colleen ROM O.S.

BASIC COMMAND FORMAT:

Commands to the monitor are entered in a line at a time in the deferred mode or with a single key-stroke in the immediate mode.

The command and the optional suffix are always entered in after necessary address and data entries.

Examples:

<u>Format</u>	<u>Example</u>
Command Suffix	DX
Adr Command Suffix	1000/Q
Adrl.Adr2 Command Suffix	1000.1100/Q
Adrl.Adr2, Data Command	1000.1100,00#
Adrl.Adr2, Adr3 Command	1000.1100,1003M

"Adrl.Adr2" indicates start and stop addresses.
"Adr3" indicates destination address, "Suffix" is always optional. "Deferred" commands are line oriented and all key entries are stored in a buffer until <CR> is hit. The buffer can be modified prior to execution using various key buffer operators.

COMMAND DESCRIPTIONS:

The following descriptions are organized into the following groups:

- List and Modify Memory
- Macro Memory Operators (Move, Verify, etc.)
- Patching Command
- Program Loading and Saving
- Key Buffer Operators
- Functions for Running Programs
- Suffixes
- Relocation Register
- Terminal Control
- PDP-11 Communications

In the following descriptions, Mode "D" is the deferred mode and "I" is the immediate mode. (See descriptions above.) All values are in hexadecimal.

Reset Modes

- CR - Cold reset clears all breakpoints, patches, vectors, step-mode, hardware, etc.
- C - Cool reset clears everything except breakpoints, patches, "K" macros, and "J" macros.
- W - Warm reset clears hardware only.

LIST AND MODIFY:

<u>Command</u>	<u>Mode</u>	<u>Description</u>
----------------	-------------	--------------------

R	I	<u>Display user CPU registers.</u>
---	---	------------------------------------

EX: User types- R

Monitor prints:

PC=20000 P=00 A=01 X=FF Y=FF S=EA

/	D	<u>List memory</u> from start to stop address. Or, if start address only is specified, all locations up to the next address increment of sixteen will be listed.
---	---	--

EX: User types- 1000.1008/ (echoed)

Monitor prints after return:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1000 =	AA	00	A9	11	01	FF	21	BC	C9							

EX2: User types- 100A/ (echoed)

Monitor prints after return:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
100A =											B9	01	21	C9	00	D0

EX3: User types- 2000.2006/Q (echoed)

Monitor prints after return:

2000	LDA	I,0FF
2002	STA	Z,10
2004	DEX	
2005	BNE	2028

/	I	When no address is specified, list the next sixteen locations starting from the last list address plus one. Allows convenient continuous listing.
---	---	---

EX: User types- / (not echoed)

Monitor prints:

1010 = AA 99 24 32 7D A9 C0 0D (etc.)

LIST AND MODIFY (continued)

<u>Command</u>	<u>Mode</u>	<u>Description</u>
----------------	-------------	--------------------

SHIFT /	I	<u>List one location.</u>
---------	---	---------------------------

EX: 1000/ (echoed)

Monitor reprints line on shift /:

1000 = A9

A repeat of just the shift / prints:

1000 = A9 again

(This is useful for reading PIA ports)

:	D	<u>Modify memory.</u> Opens memory for modification starting at specified address. Memory is not actually modified until carriage return is hit or until address passes over an increment of sixteen. (Automatic carriage return for continuous entry.) All key buffer operators can be used. (Rub, escape, etc.)
---	---	---

EX1: User types- 1000: (echoed)

Monitor prints:

1000 = Ø 1 2 3 4 5 6 7 8 9 A B C D E F

The cursor is then positioned under "Ø" waiting for a user entry.

EX2: User types- 1000: (echoed)

Monitor prints:

1000:Q

The monitor is now waiting for the user to enter in mnemonics.

LIST AND MODIFY (continued)

<u>Command</u>	<u>Mode</u>	<u>Description</u>
----------------	-------------	--------------------

:	I	Modify memory starting at start of prior listing. Or, modify user CPU registers if "R" command preceded ":" command. All other characteristics are identical to ":" in the deferred mode.
---	---	---

EX: User types- 1000/

Monitor prints locations 1000-100F as shown above.
User then types : (not echoed)

Monitor prints:

1000:

The monitor is now waiting for user entry. Note: If listing was made using the immediate mode "/", the beginning of the current line will be opened for modification.

SHFT:	I	<u>Modify one location.</u> Immediate modification of one location.
-------	---	---

EX: User types- SHFT:

Monitor prints:

1000:

Only this one location will be modified and address location pointer is not incremented.

K	D	<u>Macro Listing Command.</u> A macro listing command used during trace or under user control. Up to six single locations or lists (of any length) can be specified and then listed either during breakpoint/step operation or when "K <CR> " is specified. To set these, specify: Adrl.Adr2 - List, Adrl - Single location. Separate with commas, and end line with "K <CR> ." Any number of entries (up to six) are allowable and can be in any order. The "X" suffix clears the "K" directory.
---	---	---

EX: User types- 00.0F,4094,4021K

When a breakpoint occurs in a user program, or if the user types in "K <CR> ", the monitor will print:

	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000 =	AA	10	00	00	FF	00	10	01	11	AC	C9	F0	D0	00	00
4094 =	21														
4021 =	A2														

Note that if trace mode is set, the listing will be made after every breakpoint, whereas, if the trace mode is not set, the listing will be made after passing through the breakpoints "N" times as set by the "N" command.

MACRO MEMORY OPERATORS

<u>Command</u>	<u>Mode</u>	<u>Description</u>
----------------	-------------	--------------------

M	D	<u>Move memory</u> from start address to stop address to destination address. Accounts for direction of move to prevent memory destruction in overlapping moves.
---	---	--

EX: User types - 1000, 10FF, 1003M

Monitor then moves block up three bytes.

!	D	<u>Program 2708 EPROM's</u> using Byte-Saver board. Specify source start and stop addresses and destination address (Byte-Saver address). Any number of bytes can be programmed at a time without timing problems as the program always maintains at least a "1K Duty Cycle" to prevent damage to the PROM.
---	---	---

EX: User types- 1000.13FF,8000!

Programs RAM area 1000 to 13FF to the PROM located at 8000.

Monitor then prints:

PROM AREA O.K.

IS PROGRAMMER UNPROTECTED & READY?

The user then types either "Y" for yes or "N" for no. Yes starts the programmer, no returns control to the monitor.

Note: This program must be downloaded first. The download sets all vectors needed. (BYTSVN.MOS)

=	D	<u>Compare memory.</u> Compare one block of memory with another. Specify start and stop addresses of one block and start address of block to be checked (Adr3)
---	---	--

For example, see move instruction and verify instruction.

V	D	<u>Verify proper memory operation</u> by writing "55" and "AA" to locations, while saving current contents for non-destructive checking. Specify start and stop addresses.
---	---	--

EX: User types- 2000.3000V

Monitor prints:

First error 2400
Total errors = 1024

MACRO MEMORY OPERATORS (continued)

<u>Command</u>	<u>Mode</u>	<u>Description</u>
#	D	<u>Fill memory with specified data byte, starting at Adr1 and ending at Adr2.</u> <u>EX:</u> 1000.1FFF,00# will set locations 1000 to 1FFF with "00."
J	D or I	<u>Macro Command Files.</u> Up to eight (0-7) separate lines of commands can be stored and later recalled without having to re-enter all addresses, data, etc. This is useful for periodically listing a section of memory, setting breakpoints, etc. Setup Macro Command: <u>EX:</u> 1000.10FF/3J - Sets macro command file #3 to 1000.10FF/. Execute Macro Command: <u>EX1:</u> 3J - Execute command set up in above example. <u>EX2:</u> J - Immediate command to execute contents in file #0. List Macro Command: <u>EX:</u> 0/J - List zero macro command file. Delete Macro Command: <u>EX:</u> 7JX - Deletes macro command file #7.

PATCHING COMMAND

<u>Command</u>	<u>Mode</u>	<u>Description</u>
I	D	<u>Insert patch in program.</u> Allows user to specify an address in the program under development and insert instructions at this address without affecting the rest of the program. The monitor actually places the patched code in a "Patch Area" and inserts a "BRK" at the user program address upon starting the program. Utilizing a "Patch Directory," the monitor is able to vector the user program to the proper patch in the patch area upon encountering a "BRK." The patch has already been constructed automatically to jump back to the user program.

EX:

 User Program
1000 LDA I,00
1002 STA ZX,03
1004 DEX
1005 BNE 1000

Insert "DEY" at 1002.

Patch area:

40A6 DEY
40A7 STA ZX,03 Added automatically
40A9 JMP 1004 by patch program

Or, insert "BPL 1010" at 1005

Patch area:

40C6 BMI 40CB
40C8 JMP 1010 This structure automatically
40CB BEQ 40D0 constructed by patch program
40CD JMP 1000
40D0 JMP 1007

Note that upon return to monitor, all "BRK" instructions are replaced with the original instruction making the patch transparent upon listing.

Eight blocks of 32 bytes each are maintained in the patch area. Thus, a maximum of eight patches can be made. If a patch consumes more than 32 bytes, it will automatically link itself to the next patch area block provided the block is free.

A patch is specified by entering in the address, the desired patch number (optional - automatically finds available patch), the "I" command, and a carriage return. The desired instructions are then entered in mnemonics a line at a time. Two carriage returns in a row will terminate the patch.

PATCHING COMMAND (continued)

<u>Command</u>	<u>Mode</u>	<u>Description</u>
----------------	-------------	--------------------

The patch is effectively placed just prior to the address specified. Note that this type of patch consumes an average of 100-200 processor cycles and should not be used in time critical operations.

IX	D	"AdrIX" deletes that patch. "Ø, Patch#IX" also deletes one patch.
----	---	--

EX: Ø, 4IX deletes patch #4
"IX" deletes all patches

LISTING & SAVING PATCHES

"I" lists patch directory for reference use.

To save patches and breakpoints, write locations CØ64-CØA5 to the disc or tape. Note that this will also store the trace mode, relocation register, and step counter. DO NOT RECORD this section while in step mode. Always load this section before setting step mode.

PATCH & BRKPNT WARNING

If a location that is a patch is modified, that patch will be deleted from the patch directory. But, if the location is changed to a ØØ, the old patch code will be replaced and the patch maintained, even though the program will not run correctly. Care should be taken when modifying patched code. References to patches here also apply to breakpoints.

PROGRAM LOADING/SAVING

<u>Command</u>	<u>Mode</u>	<u>Description</u>
L	D	<u>Loads data from terminal or auxiliary port in the standard MOS Technology LOAD format.</u> Returns control to monitor upon receipt of an ASCII DC3 (Control X-Off). No address is specified. Note that tapes made with this monitor contain the "L," <CR> and DC3, so loading is done by simply turning on the tape. Echoes on terminal if trace mode is set.
W	D	<u>Write hex to terminal or to auxiliary port in standard MOS Technology format.</u> Specify start and stop addresses in the usual fashion. Note that an "L," <CR> and DC3 are transmitted at the proper times to allow simple re-loading.
"	Suffix	<u>Select auxiliary port load or write.</u> Add as a standard suffix to the L or W commands. See "PDP-11 Communications" for uploading and downloading from PDP-11.

KEY BUFFER OPERATORS

RUB	I	<u>Delete Last Entry.</u> Rubout - erase last entry. On Lear Siegler, underscore is equivalent; i.e., shift is not required.
Line Feed	I	<u>Non-Destructive Advance.</u> Advance one address or one instruction (in mnemonics mode) if first entry of line, or one character in any other mode. Does not affect contents of buffer or memory. This should be used only to skip a previous entry. Space should be used initially if skips are desired.
Space	I	<u>Delete Current Entry and Advance.</u> Erase previous key entry and advance one address if modifying memory in hex mode. Otherwise, print non-functioning space character.
Backspace (Control H)	I	<u>Back Up One Address.</u>
Escape	I	<u>Delete and Escape Current Line.</u>
CR	I	<u>Execute Current Line.</u>

FUNCTIONS FOR RUNNING PROGRAMS

<u>Command</u>	<u>Mode</u>	<u>Description</u>
G	D	<u>Go From Start of Program.</u> "GO" starting either at specified address or at address specified in previous GO command if no address is specified, (for restarting program).
		EX: First Pass: 1000G
@	Suffix	Starts program at 1000. Thereafter, typing only a "G <CR> " will start program at 1000. Attach to "G" command to run a subroutine. Note: All user registers valid except PC.
P	I	<u>Proceed From Current Program Address.</u> (Proceed from BREAKPOINT, SINGLE STEP, Control C, etc.)
S	D	<u>Set single step mode</u> (Use SX to reset to continuous mode.) NOTE: If Coleen ROM O.S. is used, LNBUG5 address prom must be used also, see Appendix on Interrupt Handling.
T	D	<u>Set trace mode</u> (use TX to reset). Lists breakpoint #, CPU registers, next instructions, and any memory locations as specified in K command upon breakpoints or single step. Also used to specify an echo upon loading programs via the terminal (See "L" command.)
N	D	<u>Set Number of Steps or Breakpoints.</u> Set number of times through breakpoints or single step before tracing and returning to monitor. Specify any hex number up to "FF." Note that "0N" will run continuously. Specifying just N with no number defaults to 01. EX: "10N <CR> " will cause 16 breakpoints or steps to run before stopping.
B	D	<u>Set Breakpoints, List Breakpoints.</u> Specify as: ADR,#B where # is the breakpoint number (1-8). Specifying 0,#BX will delete that breakpoint. BX deletes all breakpoints. "B" only lists breakpoint directory.

EX: User types- 1004,3B

Run Program (trace mode set, N=02).

Monitor prints:

```
#3 PC=1004 A=01 X=FF Y=00 S=FA BNE 1000
#3 PC=1004 A=01 Y=FE Y=00 S=FA BNE 1000
```

CAUTION: See warning in "I" instruction about modifying location specified as a breakpoint or patch.

FUNCTIONS FOR RUNNING PROGRAMS (continued)

Control C I Reenter Monitor From User Program.
Returns control to monitor while running a user's program. Uses IRQ interrupt processing. Will not function if vectors are changed or interrupt flag is set.

SUFFIXES

Q Set Mnemonics Mode. Used to cause monitor to speak and listen in mnemonics rather than hexadecimal. Applies only to "/" and ":" commands. This is a single pass assembler and maintains no symbol handling capabilities. "I" command assumes mnemonic mode. For examples see "/" and ":" commands.

X Delete suffix - used to reset trace and single step and delete breakpoints, patches, terminal modes (H & D), and K listing. Note that using only a command and the X suffix deletes all breakpoints, patches, or K listings.

RELOCATION REGISTER

Y D Set relocation register address. For use with relocatable program sections (CSECT).

Y Suffix Add Relocation Register to Address. Used as a suffix to any address that is a relative address and must have the relocation register added to it.

EX:

- 1.) 1000Y <CR> sets relocation register at 1000.
- 2.) 01A2Y/<CR> lists locations 11A2 thru 11AF on screen.

TERMINAL CONTROL

H D Set Hard Copy Mode. Sets monitor to use hard copy control set as well as delaying carriage returns and not double printing for such operations as rubout.

Upon cold reset, the monitor assumes the Lear Siegler video terminal control set. Use "X" suffix to reset hard copy.

PDP-11 COMMUNICATIONS

```

$      D      Enter bidirectional communications between  

          terminal and PDP-11 host computer.  

          Note: Since no buffering is used, the LNBUG  

          terminal should always run faster than the  

          computer baud rate. Since trace memories  

          require 19,200 baud, this should not be a  

          problem.

^ D      I      Return to LNBUG monitor from "$." (All  

          other characters are passed on to the PDP-11.)

U      D      Upload from LNBUG to PDP-11. Specify start  

          address and stop address in standard format.  

          User will now be talking directly to the PDP-11.

```

EX: 1000.12FFU <CR> <CR> (user enters)

```
.TSX Ver 3          (PDP-11 echoes)
12-Mar-79
```

```
.UPLOAD filnam.ext      (User enters)
$ <CR>  <CR>
*Now entering LNBUG #4 (LNBUG re-entered)
```

Download to LNBUG from PDP-11.

```
EX:  T <CR>          (User enters)
      $ <CR>          (User enters)
```

```
.TSX Ver 3          (PDP-11 echoes)
12-Mar-79
```

```
.DLOAD filnam.ext      (User enters)
```

```
;182000 ~~~~~(Data)  (PDP-11 sends data)
```

Now entering LNBUG #4 (Back to LNBUG)

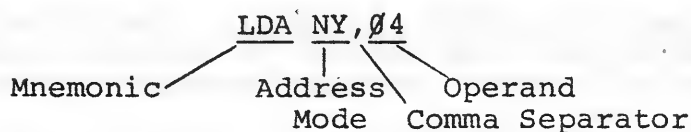
Note: "Upload" allows only 4.5 KB (approx.) of loading per file unless upload command file is modified (TSX).

APPENDIX

ASSEMBLER/DISASSEMBLER FORMAT

The format for the assembler is identical to that of the Atari MAC65 format (excluding symbols). This assembler is a 6500 adaptation of the RT-11 MACRO, written by Dave Sheppard of Coin-Op Engineering.

EX:



Note that the development assembler does not recognize symbols and all operands must be in hexadecimal. The "Y" relocation suffix can always be specified. Branch instruction operands are specified as the absolute (or relocatable "Y") address. The offset address is then calculated from this address.

If an error is detected, the assembler prints the error message and then returns the cursor to the beginning of the line for re-entry of that line.

To terminate assembly, hit carriage return without entering any other keys (blank line).

Address Mode Specification -

- (none) - Relative, Implied, Accumulator, or Absolute (Default).
- I - Immediate
- A - Absolute
- Z - Zero Page
- NX - (Indirect,X)
- NY - (Indirect),Y
- ZX - Zero Page,X
- AX - Absolute,X
- AY - Absolute,Y
- N - Indirect
- ZY - Zero Page,Y

NEW COLLEEN ADDRESS MAP
August 23, 1979

RAM	0-5FFF
ROM	6000-7FFF
RAM	8000-Bfff
LNBUG RAM	C000-C7FF
PROM SOCKET	C800-CFFF
D000	CTIA
D100	VACANT-ON CARD
D200	POKEY
D300	PIA
D400	ANTIC
D500	EXTERNAL
D600	S100 IO
D700	ACIA'S
D800-Dfff	ON BOARD RAM
E000-FFFF	RAM/O.S. ROM

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MONITOR SUBROUTINES

The following subroutines can be called by a user's program for terminal communications and other useful functions. To use, assemble the file MONSBR.MAC with the user program. It is a set of equates that call the routines. (File on G.V. System Disc).

The following describes the routines:

GETKEY=6000	Get character from terminal
GETHX=6003	Get two ASCII characters & compact to hex byte
PRINT=6006	Print ASCII character on terminal
HXPRNT=6009	Print hex byte in two ASCII characters
SP=600C	Print space
BAKSP=600F	Print backspace
RETURN=6012	Carriage return line feed w/delay for hard copy
LINEFD=6015	Linefeed only
HTAB=6018	Tabulate non-destructively N spaces
KEYHND=601B	Master keyboard handler has rubout, advance, back up, etc. Characters are put in "buff" starting at location BUFF+1F and working backwards to BUFF. The X register is returned with a pointer where BUFF+X points at the last entry. To retrieve additional characters, increment X until X=1F. A maximum of 32 characters can be entered into buffer. The 33rd entry will cause a return with the zero flag not set.
LSTHEX=601E	List hex from start to stop addresses. Set the following locations: 82,8A - Start ADL 83,8B - Start ADH 86 - Stop ADL 87 - Stop ADH Note that pseudo locations are printed for 00-03
LSTHED=6021	Same as LSTHEX except adds header to printout
LSTQ=6024	List mnemonics from start to stop. Set parameters as shown above.
DISASM=6027	Print current instruction in mnemonics. Specify only start address parameters above.
WARMST=602A	Monitor re-entry point
TDELAY=602D	Carriage return delay (10 null characters)
HEXX=6030	Converts ASCII character to LSD hex
KEYSTATUS=C0B2	6850 status save cell for processing user keyboard interrupts (6850 status register is not valid if a key has caused an IRQ int).
BUFF=C03E	Key buffer
USIRQL=C2B8	User IRQ vector under Coleen ROM O.S.
USIRQH=C2B9	
HIRQL=FFF8	User IRQ vector without Coleen ROM O.S.
HIRQH=FFF9	

DEVELOPMENT SYSTEM SWITCHES

z-2 BOX - RESET: POC to complete system.

TMI - TERM. Set baud to monitor terminal. Set one
(1) switch only for desired rate.

AUX Set baud rate for 2nd serial channel.
A15-8 Address decode of 2 serial channels.
COLEEN Set for D7 negative logic-A15 A14 A13 A12
A10 A9 A8

POLARITY Up for Aux port connection to PDP-11 (Term.)
Down for Aux port connection to term. (Comp.)

PROCESSOR (GVA-2503 Only)
RESET Local reset to processor and associated TMI
1 MHZ Selects processor clock
2 MHZ Use only one switch at a time. (ON=SELECT)
EXT CLK
JOLT/PROM Selects one of two address decode maps,
(ON=JOLT, OFF=LNBUG)
BOOTSTRAP Enables power-on remapping of 7FFF to FFFF.
(Force A15 on reset if switch is on)
BUS DISC. Enables processor to system buss vs. stand
alone (ON=normal, OFF=disconnect).
W.D. DISABLE Kills a .1 s hardware watchdog reset.
(ON=DISABLE WATCHDOG)
COLEEN PROC. W.D., BUS DISC, BOOTSTRAP, JLT, EXT. CLK., 2,1.
TRACE MEMORY W.D., BUS DISC, BOOTSTRAP, JLT, EXT. CLK., 2,1.

16K SYSTEM:

DYNABYTE RAM

BANK SELECT 1-8 open: 9 on
WRT PROT 1-5 open
BANK 3&4 Set to CX & FX
BANK 1&2 Set to 00-1F

32K SYSTEM:

DYNABYTE - Set as above, except:
BANK 1&2 Set to FX & CX
BANK 3&4 Set as desired - See Address Map

IMS RAM - 32K systems only

J2	uWr
Mem addr	0 (00-3F)
J1	on, sp
J4	8, 4, 2, 1
J5	2, sp
Addr: 7-6	3
5-4	3
3-2	3
1-0	none

DEVELOPMENT SYSTEM SWITCHES (continued)

DRC PROM CARD

D9-D16 n.c.
D1-D8 diodes
WAIT 1-14 jumpered
Select 2-7,3-6 jumpered

16K PROM CARD (Cromemco)

Bank 0-7 off
OUT off
A15 off
DMA off
A14 on
Disable ROM's 0-7
Wait Disable

TUART optional

1,3-6,8,10 ON
2,7,9 OFF

BYTESAVER optional

A15-Hi A14-Lo A13-Hi A0-BF
Wait N.C.
Protect - Off when programming

TERMINAL FORMAT

The 6850 serial communications ports are configured by software upon reset as follows:

7 Data bits
1 Stop bit
Even Parity

Baud rate is set by switches on the trace memory interface card. Recommended speed when used with TRACE MEMORY, 19,200 baud.

INTERRUPT HANDLING

If RAM resides at interrupt vector locations FFF8-FFFF, LNBUG will always point IRQ's and NMI's at it's own programs upon cool or cold reset. HIRQ (FFF8 and 9) is then used for the user IRQ vector. If ROM resides at FFF8-FFFF, LNBUG will give the user the option to have Colleen vectors point at LNBUG. If the option is selected, Colleen vector VIMIRQ (216) will point at LNBUG's IRQ routine and USIRQL (C288) will point at the user IRQ routine. Also, thereafter, anytime single step is selected, LNBUG will use NMI vectors at VVBLKI (222). If option is not selected, vectors for Colleen will be untouched and "ROMFLG" will be reset. "ROMFLG" controls options in setting single step vectors and in selection either HIRQ or USIRQ for IRQ vectors after going through the LNBUG IRQ routine.

CAUTIONS:

If interrupts are to occur while LNBUG is running, no interrupt routine should use zero page locations 80-9F as this will crash LNBUG.

NEW FEATURES OF LNBUG 6.0
June 3, 1980

LNBUG 6 is an updated version of all previous LNBUG monitors, obviously expected to be as complete as ever needed but undoubtedly due to change:

1. Cool Reset - Resets everything except patches, breakpoints, and macro commands. Type "C" upon reset.
2. Macro Command Files - Save up to eight command lines for later use without retyping addresses, data, etc. (J command)
3. Loading and Writing to tape now has a switch ("") to allow selection of either terminal port or auxiliary port.
4. Uploading and Downloading and Other PDP11 Communications - LNBUG 6 contains a simple method to communicate with a time-share system including uploading from LNBUG and downloading to LNBUG. For previous LNBUG 3 users, ^D replaces ^S for return to LNBUG.
5. Read-Modify Sequence - When listing a line at a time using the "/" immediate command, the beginning of the last line is opened for modification rather than the address that the whole listing began.
6. Zero Page RAM - To allow development of Stella (Video Computer System) programs, the required LNBUG zero page RAM has been moved from 00-03 to 80-96. (Stella has no RAM at the bottom of zero page). This should make little difference in user program operation as LNBUG retains a pseudo zero page for the user. See "CAUTIONS" for further details.
7. Carriage Return Delay - Instead of delaying a clock-dependent time for hard copy, the delay program simply outputs 10 null characters instead - (Baud rate dependent).
8. Interrupts and Single Stepping - A correction has been made to allow single stepping through an interrupt program without fouling up the interrupt status. However, due to inherent conflictions of hardware and the variable complexity of interrupt structures versus a debug monitor (real time versus stop time), problems may still arise. It is recommended that a trace analyzer be used for real time operations.
9. Colleen RAM O.S. - See section at end of manual for update on interrupt vector handling. Replace Address Map "ROM" with Colleen Address Map "PROM."
10. RAM Relocation - RAM has been moved to C000-C2FF.

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11. Single Step - With Colleen ROM O.S. you must use the new address PROM to prevent single stepping at E7XX.
12. Relocation Registers - Seven more relocation registers have been added to allow flexible debugging of several relocatable program sections.

EX: Setup - 1000,2Y Run - 1000Y2/Q Y=0-7
13. Break Key now sends a break condition to the aux. port when in the "\$" mode.
14. Problems with proceeding from a breakpoint and using multiple passes through a breakpoint or single step have been fixed.
15. Run Subroutine Command - To run a subroutine and return to LNBUG upon the RTS, specify as ADR G@ or G@.
16. Enable Interrupts during LNBUG. Set the Z command. To reset specify ZX.
17. User can initial stack at desired location by typing "S" and then MSD of stack address immediately following reset button. LNBUG then does a cold start. A cool or warm start reinitializes stack at previous value. This feature is useful for development of programs where no memory resides at 1FF.
18. PROM programming has been moved to RAM. BYTSVN must be downloaded first before command can be used.

OTHER DEVELOPMENT SYSTEM CHANGES AND ADDITIONS

June 3, 1980

1. New baud rate switches to be mounted on front panels.
2. Colleen processor card with Colleen chips.
3. Colleen address map and RAM requirements have been changed.
4. Changes to gradually be implemented on the TMI cards add higher quality connectors, Aux. port polarity switch, separate connector to allow the use of a terminal for LNBUG only and one for the trace memory.
5. Trace memory - See trace memory manual.
6. Updated trace memory manual and LNBUG 5 manual.

For answers to questions, please contact Larry Nicholson, Cyan Engineering, Grass Valley (916) 273-6194.

NEW FEATURES OF LNBUG 6.0

December 12, 1979

LNBUG 6 is an updated version of all previous LNBUG monitors, obviously expected to be as complete as ever needed but undoubtedly due to change!

1. Cool Reset - Resets everything except patches, breakpoints, and macro commands. Type "C" upon reset.
2. Macro Command Files - Save up to eight command lines for later use without retyping addresses, data, etc. (J command)
3. Loading and Writing to tape now has a switch ("") to allow selection of either terminal port or auxiliary port.
4. Uploading and Downloading and Other PDP11 Communications - LNBUG 6 contains a simple method to communicate with a time-share system including uploading from LNBUG and downloading to LNBUG. For previous LNBUG 3 users, ^D replaces ^S for return to LNBUG.
5. Read-Modify Sequence - When listing a line at a time using the "/" immediate command, the beginning of the last line is opened for modification rather than the address that the whole listing began.
6. Zero Page RAM - To allow development of Stella (Video Computer System) programs, the required LNBUG zero page RAM has been moved from 00-03 to 80-FF. (Stella has no RAM at the bottom of zero page). This should make little difference in user program operation as LNBUG retains a pseudo zero page for the user. See "CAUTIONS" for further details.
7. Carriage Return Delay - Instead of delaying a clock-dependent time for hard copy, the delay program simply outputs 10 null characters instead - (Baud rate dependent).
8. Interrupts and Single Stepping - A correction has been made to allow single stepping through an interrupt program without fouling up the interrupt status. However, due to inherent conflictions of hardware and the variable complexity of interrupt structures versus a debug monitor (real time versus stop time), problems may still arise. It is recommended that a trace analyzer be used for real time operations.
9. Coleen ROM O.S. - See section at end of manual for update on interrupt vector handling. Replace Address Map "ROM" with Coleen Address Map "PROM."
10. RAM Relocation - RAM has been moved to C000.
11. Single Step - With Coleen ROM O.S. you must use the new address PROM to prevent single stepping at E7XX.

NEW FEATURES OF LNBUG 6.0 (continued)

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12. PROM programming capability has been moved to system hard disk and out of PROM.
13. Addresses of stop and start addresses for calling list routines have changed to the following:

82,8A	Start ADL
83,8B	Start ADH
86	Stop ADL
87	Stop ADH
14. Half of zero page is now saved to allow proper stack operation with the VCS - LNBUG uses no more stack than an interrupt before zero page is saved.
15. Hitting the break key while in "PDP11" mode will send a break out aux. port.
16. @ Suffix runs subroutines when added to "G" command.

OTHER DEVELOPMENT SYSTEM CHANGES AND ADDITIONS

1. New baud rate switches to be mounted on front panels.
2. Coleen processor card with Coleen chips.
3. Coleen address map and RAM requirements have been changed.
4. Changes to gradually be implemented on the TMI cards add higher quality connectors, Aux. port polarity switch, separate connector to allow the use of a terminal for LNBUG only and one for the trace memory.
5. Trace memory - See trace memory manual.
6. Updated trace memory manual and LNBUG 6 manual. (Please change pages supplied.)

For answers to questions, please contact Larry Nicholson, Cyan Engineering, Grass Valley (916) 273-6194.